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ABSTRACT

Along with cost, and hence availability of hardware and quality educational courseware, the major barrier to full implementation of microcomputers is the lack of knowledge possessed by researchers and educational practitioners alike regarding the nature of the knowledge, skills, and attitudes a teacher must have to successfully use microcomputers in classroom instruction. In evaluating the success of classroom computer use, the inclination is to pit technology against "regular instruction" and to compare the effects of these alternatives on student achievement. The premature conclusion may be that computer technology offers little incremental benefit. A process analysis would focus on how teachers integrate computer activities into classroom instruction, including the consequences of degrees of integration for outcomes of instruction such as student achievement and motivation. Successful classroom computer use is inherent in teachers' planning, decision making, and evaluation of instruction. The teacher decision-making perspective suggests several dimensions that should be included in the evaluation--goals, curricula, computer-based learning activities, integration, and feedback. Because the proposed definition of successful computer use focuses on preactive, interactive, and evaluative processes rather than products like standardized test scores, a naturalistic and field-based research approach is suggested. Nine references are listed. (LMM)

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"SUCCESSFUL" USE OF MICROCOMPUTERS IN CLASSROOM INSTRUCTION[1]

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A widely shared belief among many policy makers, educators, parents, and the general public is that microcomputers have the potential to help pull U.S. education out of its current state of mediocrity (National Commission on Excellence in Education, 1983), and subsequently improve its quality. A number of barriers, however, impede the widespread implementaion of microcomputers in classrooms. Along with cost (and hence availability of hardware and quality educational courseware), the major barrier to full implementation is the lack of knowledge possessed by researchers and educational practitioners alike regarding the nature of the knowledge, skills, and attitudes a teacher must have to use microcomputers successfully in classroom instruction (Hall, 1981; Romberg and Price, 1981).

This paper addresses the standard implied in such an evaluation, that is, the nature of "successful" classroom microcomputer use that might be embodied in the teaching of widely recognized, expert or master teachers. We advance a preliminary definition of "successful" microcomputer use to encourage evaluators, policy makers, and the lay public to resist their inclination to focus solely on student achievement measures. From the teachers' standpoint, microcomputers are an educational technology used as an instructional tool. Thus, the application of the instructional tool should be central to such an evaluation, within the broader context of ongoing classroom instruction.

TECHNOLOGY AND THE PROCESS OF INSTRUCTION

In evaluating the success of classroom computer use, the inclination is to pit technology against "regular instruction," including teacher and text, and to compare the effects of these

alternatives on student achievement. Based on previous evaluations of educational technologies such as hand-held calculators or audio-visual aids the likely outcome of such an evaluation is predictable--technology will "win" about half the time and so will the teacher (Dubin and Taveggia, 1968). The premature conclusion may be that computer technology offers little incremental benefit.

Clearly, part of the explanation for such results could be that the best examples of either the technology's capability or of the teacher's may not have been represented adequately in the study. Other limitations of this research approach are not likely to be appreciated. For example, the courseware used in the evaluation may not have exploited the system's capabilities, and potentially important outcomes beside students' performance may remain unevaluated.

An instructional technology need not compete with teachers; rather, they are a tool available for teachers to use. Thus, an alternative approach would be a process analysis that focuses on how teachers integrate computer activities into classroom instruction, including the consequences of degrees of integration for outcomes of instruction such as student achievement and motivation. A useful framework derives from theories of teaching that may be termed "teachers' decision making" (e.g., Shavelson, 1973; 1976; Shavelson and Stern, 1981) or clinical information processing (Shulman and Elstein, 1975). The principal benefit of this perspective is that it emphasizes cognitive and behavioral aspects of instruction. This framework helps to define successful computer use because it suggests specific teaching decisions and tasks in which computers may play a role. The success of classroom computer use may consequently be evaluated with respect to these ongoing decisions and tasks.

TEACHERS' DECISION MAKING

The basic premise of the decision making approach is that instruction is an ongoing process under the active direction of teachers. Instruction is viewed as multifaceted, in which goals, content, activities, and teaching methods are orchestrated by teachers in order to provide a flow of activity toward hoped-for outcomes. Teachers' plans are a central focus of this conceptualization. In formulating and evaluating plans, teachers integrate information about students, the subject matter, and the classroom and school environment in order to reach judgments or decisions that guide instructional activities. Furthermore, teachers monitor ongoing activities. If activities are proceeding as planned, teachers concentrate on maintaining the flow of activity. If the activities are not going according to plan (i.e., some disruption occurs), they activate a routine for handling the problem. A final monitoring loop occurs when teachers evaluate the outcomes of instruction in order to improve planning. (For a detailed presentation of the underlying cognitive theory, see Shavelson, 1981; Shavelson and Stern, 1981.)

SUCCESSFUL COMPUTER USE

To begin to define "successful computer use," we first assume that computer use fits within this ongoing planning and decision-making process. Next, we assume that teachers can make reasonable choices among alternative courseware for reaching one or some combination of educational goals, and among the modes of instruction given their knowledge of the subject-matter, computers, and the characteristics of students in their class. We believe that "successful" classroom

compute: use will occur when teachers make reasonable decisions about matching the computer and available courseware to the instructional goals, the structure of the subject matter, the nature of the students, and the context of instruction. Nevertheless, once the planning decisions have been made, the teacher must possess the interactive teaching skills in order to carry out the plan. Finally, teachers must monitor their ongoing instruction, take appropriate steps when warranted, and retrospectively evaluate their decision rules, choices of courseware, and so on in order to improve the match between computer activities and other facets of ongoing instruction.

The above discussion suggests that "successful classroom computer use" is inherent in teachers' planning, decision making, and evaluation of instruction. In general, it suggests that the successful use of computers be defined as the degree to which computer activities are integrated into teachers' planning processes, in the sense that there should be a relationship between computer activities in the classroom and other instructional activities and tasks. However, there are two issues relevant to this integration--there are uses and then there are successful uses. Thus, we need to expand this definition to allow for the pedagogical value of classroom computer use. Accordingly, we propose a general definition of "successful classroom computer use" that takes the elements of planning, computer uses, and pedagogical consequences into account, as follows:

> Successful classroom computer use results from the appropriate integration of computer-based learning activities with teachers' instructional goals and with the ongoing curriculum, which changes and improves on the basis of feedback that indicates whether desired outcomes are achieved.

This definition contains a number of conceptual dimensions (underlined), which in turn contain a number of specific indicators. Table 1 presents these conceptual dimensions and indicators. They are: Instructional goals, ongoing curriculum, computer-based learning activities, appropriateness of integration, and feedback.

Teacher's Instructional Goals

One important element of the definition of successful computer use is teachers' goals for students. We focus on teachers' goals because the research framework we briefly described considers teachers' behavior to be purposive--i.e., goal oriented. One must understand what objectives teachers seek to accomplish in order to later determine the importance of an instructional tool in meeting these goals.

Teachers' goals may include outcomes that are academic, motivational, social (including behavioral management), or some combination of these. Academic goals include mastery of subject-matter concepts and of procedures. Motivational goals include such things as heightened student interest in the subject matter and positive attitudes toward the class. Social goals may foster either behavioral management or social cooperation and teamwork among students. To evaluate the "success" of classroom computer use, we need to first determine the absolute and relative importance of these instructional goals to teachers. Indeed, one of the most complex tasks faced by the teacher is that of balancing among goals within a lesson; computers introduce an additional order of complexity in this balancing act.

Table 1

ELEMENTS OF SUCCESSFUL CLASSROOM COMPUTER USE

- o Instructional Goals
  - (a) Achievement
    1. Mastery of basic skills/procedures
    2. Mastery of concepts
  - (b) Motivation
  - (c) Social
- o Ongoing Curriculum
  - (a) Subject Matter
    1. Content areas
    2. Major topics
  - (b) Course Materials
    1. Manipulables/Demonstrations
    2. Information sources (e.g., Lectures; texts)
- o Computer-Based Learning Activities
  - (a) Modes of Computer Use
    1. Drill and practice
    2. Tutorial
    3. Simulation
    4. Microworlds
    5. Games
  - (b) Grouping of students
  - (c) Time allocation among students for computer use
- o Appropriateness of Integration
  - (a) Contribution of computer use for instructional goals
  - (b) Coordination between the curriculum and computer use
  - (d) Strategies for assigning students to computer activities
- o Feedback
  - (a) Evaluation of student progress
  - (b) Use of the microcomputer for management
  - (c) Changes in computer-based activities

Ongoing Curriculum

Teachers' goals are pursued in the context of a continuing classroom curriculum that is activated through a number of instructional activities. We define the curriculum, as do teachers (Shavelson and

Stern, 1981) to include: (1) subject matter--the major content areas and important concepts that are taught within each content area; and (2) course materials--the things that students observe and/or manipulate (e.g., laboratory equipment; exercises), as well as vehicles of course content such as textbooks and lectures.

These elements are important to note because they define the range of activities in which microcomputers can be potentially integrated. For this assessment, computer use would be viewed in relation to teachers' planning decisions for coordinating computer use with the various instructional activities occurring in the class.

Computer-Based Learning Activities

Another element of our definition of successful classroom computer use relates directly to microcomputer technology as it is used in the classroom. Our theoretical perspective suggests that teachers will make important distinctions about microcomputer use during planning that differentiate among potential instructional uses.

One important distinction can be termed modes of computer use, and refers to selections teachers make among the forms of available computer applications, such as drill and practice, tutorial, simulation, microworlds, and games. A second dimension relates to grouping of students for its use--how teachers actually assign students to computer activities. Teachers may have preferences for individual use, or they may view computer activities as something to be engaged in by pairs or groups of students. A final distinction relates to the allocation of time among students or groups of students for computer activities. Teachers may decide that computer activities should be allocated to students equally, or in proportion to some criteria such as need or ability.

Appropriateness of Integration

The various elements described above come together in considering the integration of computer use with instruction, and the appropriateness of the various forms of integration. Integration of computer-based learning activities (modes of use; grouping; time allocation) can occur with respect to instructional goals and the curriculum. For example, the fact that teachers have numerous instructional goals implies that the computer could be put to a variety of alternative uses; e.g., simulation programs for goals like heightening students' understanding of a process, or games for goals like motivation. Students could be grouped or time allocations could be made in pursuit of certain goals (fostering teamwork in problem-solving; remediation of deficiencies in basic skills).

Coordination could also be made between computer-based learning activities and various elements of the curriculum (i.e., subject matter and course materials). Courseware can be selected, or mode of computer use assigned, to complement subject-matter content and existing course materials (e.g., textbooks or demonstrations). Grouping of students, and time allocations for various assignments, may also relate in some way to ongoing instructional activities.

Thus, each of the previous elements can be examined for the breadth of the match that is made between them. However, underlying the integration must be some notion of the appropriateness or pedagogical value of the strategies teachers follow in assigning students to computer use. The achievement of simple goals, such as keeping children on the computer and out of trouble, should not be considered successful

computer use. Likewise, the mix of goals is also important. For example, low ability students might continually be segregated at the computer from their peers in order to receive drill and practice. While this might optimize achievement outcomes, it changes the classroom context by isolating certain groups of students from others.

Feedback

Our model of the process of instruction indicates that teachers' evaluation and, if necessary, modification of instruction relative to their goals are an important part of teaching. To evaluate instruction, the teacher must obtain feedback about the consequences of instruction for their (a) students (e.g., their participation, time on task, attitudes, mastery of subject matter), (b) teaching routines (e.g., links between computer activities and other instructionally related classroom activities), and (c) planning decisions (e.g., selection of courseware, grouping of students).

Another element of successful computer use, then, is the evolution of computer use that occurs in response to feedback regarding its success. We have identified three indicators of the use of feedback. The first is whether teachers evaluate microcomputer activities through formal or informal evaluation of student time on task or progress. Because the computer provides an excellent way of tracking individual student progress for the purpose of instructional decisionmaking, a second indicator is whether teachers make use of the computer (or particular courseware) to provide feedback on individual student's progress on instructional tasks. Both sources of information may lead to changes in computer use through decisions like rejecting certain courseware, decreasing (or increasing) the time a student spends with the computer, and so on.

SUMMARY AND IMPLICATIONS

To summarize, we have argued that the "success" of classroom computer use be examined within the process of classroom instruction, and we have described several dimensions (i.e., goals, curricula, computer-based learning activities, integration, and feedback) that the teacher decision-making perspective suggests should be included in the evaluation.

This definition of successful computer use has important implications for how a study of classroom computer use might be conducted. Because our notion of successful computer use focuses on preactive, interactive, and evaluative processes rather than products like standardized test scores, a naturalistic and field-based research approach is suggested. Such an approach would be relational, seeking to account for the determinants of degrees or types of success without disturbing the phenomena, and would rely on participant observation and interviews for sources of data. Thereby, one can observe how the different dimensions of "successful" computer use are configured among a user population.

A second implication is methodological and concerns the problem of how the different dimensions of computer use contribute to an overall assessment of "success." Because there can be multiple strategies for using computers, success will not likely prove to be a simple, unidimensional sum of its multiple elements. Knowledgeable teachers may find particular <u>combinations</u> of computer uses to be especially effective, and there may be a further association between particular computer uses and characteristics of the learning environment, such as

grade level, subject matter, or ability level of students. This suggests that an evaluation of successful computer use might seek to identify "clusters" of "successful" computer uses. While statements about success might then prove more complex and qualified, they would provide a more accurate indication about what works best for different types of teachers in different learning environments.

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